U.S. Geological Survey Proposal

C: Ground Water Near Deer Trail, Colorado

C-1: Alluvial Ground-Water Quality

Question:

Are biosolids applications on the Metro properties near Deer Trail adversely affecting the quality of the shallow aquifers in the vicinity?

Concerns:

Biosolids applied to the land surface could affect the quality of shallow ground water directly through 1) contaminated recharge or 2) infiltration through contaminated soils or sediments (remobilization). Biosolids can also affect the quality of shallow ground water indirectly through 1) plowing that mobilizes or changes subsurface constituents, or 2) contributions to natural processes such as nitrification.

Discharge from contaminated alluvial ground water could contaminate 1) surface water (ponds or streams), or 2) bedrock water-supply aquifers

Objectives:

To determine the hydrology of the alluvial aquifers.

To determine whether concentrations of nitrate, arsenic, cadmium, copper, chromium, lead, mercury, molybdenum, nickel, selenium, zinc, plutonium, and gross alpha and beta radioactivity in the alluvial aquifers are significantly greater than regulatory limits.

To determine whether concentrations of nitrate, arsenic, cadmium, copper, chromium, lead, mercury, molybdenum, nickel, selenium, zinc, plutonium, and gross alpha and beta radioactivity are increasing with time in shallow ground water draining the biosolids-application properties.

Approach:

Monitoring wells in the alluvial aquifers will be installed by the U.S. Geological Survey (USGS) in the drainage valleys near Metro property boundaries and possibly at downgradient mixing locations. Wells will be cored when drilled to evaluate lithology. Existing USGS monitoring wells will be used when possible.

Wells will be sampled quarterly for dissolved and total nutrients, dissolved major ions and trace elements, and physical properties. Wells will be sampled annually for radionuclides (plutonium and radioactivity). Analyses will include nitrate and ammonia nitrogen, arsenic,

cadmium, copper, chromium, lead, mercury, molybdenum, nickel, plutonium, selenium, zinc, and gross alpha and beta radioactivity, as well as full nutrient, trace-element, major-element, and anion chemistry. Two additional ground-water samples (full inorganic chemical analysis including radionuclides) can be collected by USGS from the monitoring-well network each year at the request of the stakeholders. All samples will be collected using appropriate USGS protocols. Water levels and field parameters will be measured with each sample collected to provide context for the chemical analyses. Sufficient field blanks will be analyzed to enable sample bias (laboratory plus field) to be evaluated with at least 90 percent confidence after 5 years of monitoring. Sufficient field replicates will be analyzed to enable sample variability (laboratory plus field) to be evaluated with at least 90 percent confidence after 5 years of monitoring.

One new instrumentation site (known as data-collection platform or DCP) will be installed on the north Metro property where Badger Creek exits the Metro property to continuously monitor precipitation amounts and air temperature, and ground-water temperature and level. Of the two existing data-collection platforms on the central Metro property, the Muddy Creek site will continue to be monitored to provide spatial coverage and long-term record, and the Cottonwood Creek instrumentation will be moved to Beaver Creek on the south Metro property. Water levels of the monitoring-well network will be measured monthly. Aquifer tests will be made to estimate hydraulic conductivity and transmissivity.

Water-quality data will be maintained in a USGS data base and reviewed within one month of receipt from the laboratory. A newsletter will be distributed quarterly (every 3 months) to all stakeholders and interested parties; monitoring progress will be described every quarter, and reviewed hydrologic and chemical data will be included in the newsletter every other quarter. Reviewed data also will be available in electronic format. Data will be compiled into annual summaries and distributed with preliminary, reviewed interpretations at annual stakeholder meetings. Progress and scope of work will be reviewed at the annual meetings, at which time the scope of work and budget for the next year can be revised.

Data will be statistically analyzed each year, and again after about 5 years to determine if 1) concentrations are significantly greater than regulatory limits and 2) any constituents of interest are increasing significantly over time. All results of the statistical tests will have full technical review before release, and will be released with the alpha, beta, and theta levels used for the testing. Data and interpretations will be published in a report following about 5 years of monitoring.

Monitoring sites:

Any sites of interest to the stakeholders can be monitored, however some sites are critical for an unbiased monitoring program that meets the stated objectives. In general, monitoring wells need to be located in the drainage valleys near Metro property boundaries, with possibly one downgradient alluvial mixing well. The USGS study on the Metro Central property indicates that alluvial aquifers do not underly the entire property, but are present only in limited parts of the drainage valleys. Additional alluvial wells on the Metro properties could be monitored to provide information about chemical and hydrologic variability of the alluvial aquifers, but this information could be inferred from the USGS monitoring program on the Metro Central property, and this information is not needed to meet the stated objectives.

Important monitoring locations for the Metro North properties include: 1) Badger Creek mainstem on the north side of section 22 (NE1/4, S22, T4S, R58W); 2) Badger Creek

tributary (inflow) between sections 21 and 28 (NW1/4, S28, T4S, R58W); 3) Badger Creek tributary between sections 4 and 9 (NW1/4, S9, T4S, R58W); and 4) Cottonwood Creek tributary in section 35 (NE1/4, S35, T4S, R58W). The most critical monitoring sites needed near the Metro North properties to meet the stated objectives would be the locations where Badger Creek and its tributary exit the Metro properties (sites 1 and 3 above). If concentrations at these sites are near or above regulatory limits, then additional upgradient monitoring sites can be added. Monitoring "mixing sites" downgradient from the Metro properties would be of interest in evaluating regional ground-water quality, but changes in water quality at these sites could not be attributed to a specific land use (such as biosolids applications) unless the scope of the monitoring program is expanded considerably.

Important monitoring locations for the Metro Central property include Muddy Creek and Cottonwood Creek tributaries: 1) Existing USGS well D25 in section 17; 2) Existing USGS well D30 in section 15; 3) Existing USGS well D6 in section 22; 4) Existing USGS well D13 in section 32; 5) Existing USGS well D17 in section 5; and 6) Muddy Creek downgradient from the Metro Central property (section 7, 6, or 36). One of the alluvial wells discussed in the "*Option C-2: Bedrock Hydrology and Ground-Water Quality*" proposal could be monitored as a downgradient "mixing site" location for Muddy Creek, although changes in water quality at this site could not be attributed to a specific land use (such as biosolids applications) unless the scope of the monitoring program is expanded considerably.

Important monitoring locations for the Metro South property include: 1) Rattlesnake Creek, one well downgradient in section 30 (SW1/4, S30, T5S, R57W) or 3 wells along the north property boundary (S1, T6S, R58W and S6, T6S, R57W); 2) Rattlesnake Creek tributary (inflow) in section 11 (NW1/4, S11, T6S, R58W); 3) Beaver Creek (inflow) at upgradient part of Metro property (possibly S7, T7S, R57W); 4) Middlemist Creek (inflow) in section 36 (SW1/4, S36, T6S, R57W); 5) Middlemist Creek in section 24 or 25 (T6S, R57W); and 6) Beaver Creek along the north Metro property boundary (3 wells) (S1,3,4, T6S, R57W). Metro biosolids applications affect only a small part of the Rattlesnake drainage, but adequate monitoring of this drainage would require 6 wells. Monitoring "mixing sites" in the Rattlesnake drainage basin downgradient from the Metro property would be of interest in evaluating regional ground-water quality, but changes in water quality at these sites could not be attributed to a specific land use (such as biosolids applications) unless the scope of the monitoring program is expanded considerably. Therefore, the most critical monitoring sites needed near the Metro South property to meet the stated objectives would be the locations where the Middlemist and Beaver Creek (and tributaries) exit the Metro properties (sites 5 and 6 above; 4 wells). If concentrations at these sites are near or above regulatory limits, then additional upgradient monitoring sites can be added.

Benefits:

This approach will yield data useful for objectively evaluating hydrology and water quality of alluvial aquifers, as well as changes in water-quality parameters over time. Hydrologic and geochemical processes can be evaluated because extensive hydrologic and water-quality information will be collected.

Instrumentation sites (DCP's) will be useful for evaluating ground-water recharge and hydrologic variability. Rainfall data from these sites can also be used for determining

sediment and surface-water sampling times, as well as for crop or livestock management by area property owners.

Limitations:

This approach will not yield sufficient water-quality information to definitively prove that biosolids applications are causing the changes in water quality (analyses of natural isotopes or wastewater tracers, in addition to age dating, are needed to determine sources). "Background" (pre-biosolids or even pre-farming) water quality can not be determined because biosolids have been at this site for several years and much of the property has been farmed since the 1970's. Trends and statistical tests, as well as sampling and laboratory bias and variability, can be calculated each year but can not be effectively evaluated until the end of about 5 years because of the number of samples needed for a viable statistical evaluation.

Unless a monitoring well is located in every drainage valley where surface water can enter or leave the Metro property, alluvial-aquifer quality can not be completely quantified. However, about fifty drainages enter or leave the Metro properties, so monitoring a few of the major drainages on each of the three Metro properties (with or without downgradient sites where tributary aquifers mix) is a reasonable initial approach. If concentrations at the Metro borders or mixing sites are above regulatory limits, then additional wells could be installed upgradient on the Metro properties.

The USGS study on the Metro Central property indicates that nitrate concentrations in alluvial ground water in this area can fluctuate at least 19 milligrams per liter within 3 months. Therefore, sampling the wells quarterly for nutrients will not document all nutrient concentrations and may result in underestimated maximum nitrate concentrations. If maximum nitrate concentrations are of concern, then wells will need to be sampled more frequently than quarterly.

Schedule of initial monitoring:

Monitoring alluvial ground water in the vicinity of the Metro properties can begin within one month after the contract is finalized with a signed funding agreement. Much of the equipment is already available because it was obtained for the USGS monitoring of the Metro Central property (1993-98). Five of the 11 monitoring wells are already installed, and the USGS drilling team is available to install additional alluvial wells as early as November 1998, weather permitting. Well sampling can commence at any time for the existing wells, or as soon as one week after new wells are installed.